Desires for active ageing technology

Abstract
A number of technological devices have been developed over the last decade to support an active lifestyle as people age. However, despite substantial investment, they have failed to reach widespread acceptance. We attribute the problem to a generalised tendency to ground their design on a model of ageing that portrays people in decline, with little involvement of perspective users. To counteract this tendency, the paper proposes a structured methodology to collect user requirements as desires. The methodology is built on the Integrated Behavioural Model and was instantiated in an interview study (N=18) with two cohorts of older adults from Italy and the UK. Results have been collated into a model of user desires which puts the person (described in terms of attitudes, perceived norms and personal agency) as well as the sociotechnical context of use to the forefront of the designer's attention. The model is contrasted with related work and used to define new design trajectories for active ageing technology as design for pleasurable and resourceful ageing.

Introduction

The last decade has witnessed a growing interest in the analysis, development, and evaluation of technological interventions to support active ageing. The objective is to find cost-effective solutions to support independent living and the provision of care as people age. However, the results of this research failed to reach widespread acceptance due to the combination of several factors [27, 28, 76]. They include technology immaturity, incorrect requirements, inappropriate design and unsuccessful deployment. This paper focuses on the requirements phase which, we argue, is central to the problem.

Requirements describe the functional and non-functional properties of an envisioned system; consequently, they play a fundamental role in framing a design project. The importance of involving the users in requirement elicitation is broadly acknowledged and there are several techniques and tools to support it [61]. However, recent research highlighted that older people's ideas and desires are rarely sought in requirements elicitation studies [17, 27, 28, 57]. On the contrary, their needs and problems are inferred from the analysis of related work, or the opinions of caregivers and younger family members. This is a cost-effective approach, which nevertheless increases the risk of stereotyping [27]. In western societies, older people are stereotypically portrayed as frail and incompetent individuals with a specific aversion towards technology [8], a description many older citizens do not identify with [17, 27, 71]. This assumption creates a mismatch between the designed properties of an artefact and the user's self-perception, which can cause disruptions, annoyances, or even safety risks leading to product rejection [27, 76].

This paper aims to enrich our knowledge of older life for the scope of technology design. With this aim in mind, it makes two important contributions to ICT research for active ageing. Firstly, it provides a structured methodology to ensure that the needs and desires of users are acknowledged early in the design process and seamlessly integrated into the resulting artefacts. The methodology builds on the Integrated Behavioural Model (IBM)

which describes the intention to perform a behaviour as a function of attitude, perceived norm and personal agency [45]. Secondly, it provides a model of desires for active ageing technology extracted from an interview study performed at the beginning of the design cycle. Results of this study provide a rich description of older life and support the emerging critical perspective that exposes the limitations of mainstream ICT research for active ageing [28].

The paper is organised as follows. Section 2 grounds the approach in related work about active ageing and technology acceptance in older life. Section 3 introduces the context of the research, giving an overview of our project and explaining the IBM model. Section 4 reports the method and the results of the interview study (N=18) which identified the preferred activities of older adults and the factors that influenced their intention to engage in these activities. This structured knowledge informed a model of desires that is presented in Section 5. Section 6 and 7 discuss the model and provide design implications, respectively. Section 8 reflects on methodological considerations regarding technology acceptance. Finally, Section 9 concludes the paper.

Related Work

This section is formed of two parts. The first one provides an introduction to technologies for active ageing. The second part presents a critical analysis of studies of technology acceptance for older life.

Technology for Active Ageing

The Policy Framework [77] defines active ageing as "the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age". In this framework, the word *active* refers to the involvement of people in a range of activities from physical, social, economic and cultural, to routine activities [14, 36, 60, 71]. The word *ageing* refers to the entire life-course and there is an agreement that active ageing initiates in early life [73]. Health is defined as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" [78]. Participation refers to the ability of a person to make socio-economic and cultural contributions to society as they age. Security means the provision of assistance and care while simultaneously promoting independence and autonomy.

Technology has been considered a key ingredient of cost-effective active-ageing interventions. A variety of systems have been produced, ranging from monitoring systems [18] to games for maintaining engagement to prevent fall [69] or during therapy and rehabilitation [67]. In addition, robotic technologies have been widely exploited as *tools* to support mobility capacities, such as strength, balance and range of motion [12, 56], or companions [41] to assist older adults in functional and social activities. A comprehensive analysis of ICT research and development alongside the three active ageing dimensions – health, participation and security – is provided in [51]. Our reading of these works, supported by a critical gerontology perspective [37], identified two important biases that are relevant for discussion in this paper: *lack of user involvement and deficit-driven design*.

According to [16], computing research is biased towards a functional perspective to the disadvantage of the sociotechnical alternative. In the functional perspective, technology is

celebrated as the solution to the problems of older users. The problems are taken directly from medical literature and older people are rarely involved in their definition [28]. This *lack of user involvement* has resulted in a *deficit-driven approach* to design which, in turn, has led to the development of a large number of assistive artefacts. Assistive technology differs from active-ageing technology because it is designed to fix problems rather than to prevent decline and promote health [56]. This is a major obstacle to active ageing interventions, which subsume a comprehensive and preventive lifelong strategy of age management [36, 71]. Assistive technology can evoke stigma [79] and thus discourage acceptance. Regardless of their age, people like to feel independent, and a system that conveys their sense of need or disability is likely to be met with rejection or at least ambivalence.

Alternatively, the sociotechnical perspective involves older users in the design not as problems to be solved but as agents of solutions [27, 40]. Rather than focussing on providing assistance, it aims to design systems which can enhance experiences, appeal to the human need for independence and affirm a positive identity. The two foci of design – experience and assistance – are not mutually exclusive. Assistive technology can enhance experiences and in this way the design becomes inclusive [23]. Inclusive design attracts people without specific needs for assistance, because the experience is appealing [31, 53]. As an example, consider telepresence robots [13]. They may be useful for healthcare, but they may also provide new ways to communicate with friends or family. When involved in the design, older adults could envision several such opportunities, imagining for example that they could control the robot to visit new places or attend live performances remotely [7]. However, they also worried about how telepresence may affect communication etiquette and expectations, wondering that it may become invasive of their privacy [7]. These scenarios emphasized their agency and desire for autonomy and independence.

Despite the heterogeneity of activities associated to active ageing, technological interventions have mainly been concerned with physical health [28], disregarding other important factors related to well-being [36, 71]. These factors include feelings of societal worth, the desire of giving back to the community, a sense of stability or being able to adapt to changes in life, willingness to learn, perceived success of friends or family, or the ability to take time out each day to do pleasurable activities. Older people perceive active ageing as being largely associated to physical activity however, their narratives constantly entangle physical activity with social and mental activity [60].

Although physical activity cannot stop biological ageing, regular exercise can minimize its physiological effect, increase life expectancy and reduce the progression of chronic diseases [62]. Reduced physical activity in later life is partially connected to physical decline, but it also depends on psychological and sociological factors [58]. For example, low self-efficacy is generally associated with reduced physical exercise in older adults, independent of their actual physical abilities [10]. In addition, limited physical activity may be due to lack of interest, a frequent consequence for people who were forced to sustain exercise during childhood [63], or have been exposed to loss-framed rather than gain-framed persuasive messages [26]. Finally, lack of social support has been shown to hamper sustained exercising among older adults [38].

Technology acceptance

A large corpus of research in the field of Information Systems (IS) has investigated technology acceptance using a research approach based on questionnaire data and statistical modelling. This stream of research grounds on the Technology Acceptance Model (TAM) which proposed perceived ease of use and usefulness as the most influential predictors of the intention to use a system [19]. The model is a specialisation of the Theory of Reasoned Action (TRA) [1] and the Theory of Planned Behaviour (TPB) [2] two robust psychological models which consider intention as a reliable indicator of the likelihood to engaging in behaviour. Over the last thirty years, the TAM has stimulated an incredible amount of research and collected multiple critiques, specifically pertaining to its practical value in driving design [21].

A synthesis of several theoretical models is provided in the Unified Theory of Acceptance and Use of Technology (UTAUT) [70]. According to it, four components predict intention to use: performance expectancy, effort expectancy, social influence and facilitating conditions. Research on older adults has considered the UTAUT partially [6], by focusing mainly on effort expectancy and facilitating conditions. A more recent model [35] is organised around personal, social, technological and technology delivery aspects of adoption that include the following factors: value, usability, affordability, accessibility, technical support, social support, independence, affective experience, previous experience, and confidence.

A different stream of research has explored technology acceptance within a qualitative research tradition, based on interviews, focus groups and ethnographically-informed field studies. A paradigmatic example is the work of Waycott and colleagues [74], who provide a rich description on the reasons for nonparticipation in a sociotechnical intervention aimed at reducing social exclusion. Older people opted out for a variety of reasons which reflected personal barriers (health conditions and difficulty learning new things), social barriers (family circumstances and established norms) and technological barriers (difficulty in understanding the language of the device). Mitzner and colleagues [44] analysed the opinion of over one hundred older adults who participated in focus groups discussing their use of and attitudes towards mainstream technology commonly used in the context of home, work and healthcare. Contrary to stereotypical assumptions, these authors identified a generalised positive attitude towards technology in later life. Older adults reported liking technology which provided support for doing activities (communication, health monitoring, research), had useful features, and was convenient (effort reduction). Conversely, negative attitudes were triggered by inconvenience (perceived interruptions, financial expenses, and effort), useless features, security and lack of reliability.

Research Context

This section details the context of the research. First, it describes the context of the design intervention and secondly it introduces the IBM model used to frame the research.

The Acanto project

The ACANTO project was funded by Horizon 2020 as part of the European response to the challenges of an ageing population [64]. It aimed to develop a sociotechnical system to maintain wellbeing in later life while facilitating physical activity and social interaction. With respect to this goal, the design contains three technical components – a robotic walker, a

social network and a recommender system. The components may work independently or in combinations according to the specific needs of the user.

The walker named FriWalk aimed to support the self-management of physical activities by those people, who may require a physical support for independent mobility or rehabilitation. In addition, it provided monitoring of a variety of physical aspects, such as balance, strength, gait and walking speed. The social network linked together people with similar backgrounds and/or interests. It collected a variety of information about older adults and created their profiles. The recommender used the profiles to suggest new people to meet, activities to do together and places to visit, by matching users based on a variety of factors, such as shared interests, background, location, and life circumstances. The network and recommendation system were accessible through a tablet, which can be used with the walker or independently (Figure 1).

The basic technological architecture was described in the grant proposal, however the design approach was strongly user-centred and older people were involved early in the design process to understand the activities they like to engage in, and how the system may support them. This activity was facilitated by the IBM, which provided a structured framework to collect user requirements.

Figure 1. ACANTO system.

Integrated Behavioural Model

The Integrated Behavioural Model (IBM) [45] is a development of the TRA [1] and the TPB [2]. Like its predecessors, the IBM posits that the intention to engage in behaviour is a function of the *attitude*, *perceived norm* and *personal agency* related to that behaviour (Figure 2). Attitude is defined as the personal predisposition to a specific behaviour.

According to the IBM, it is determined by the experiential, emotional responses (affective attitude) and the beliefs about the outcomes (instrumental attitude) associated with a given behaviour. The perceived norm reflects the social pressure one feels to perform (or not to perform) a behaviour. This pressure is based on what other people think one should do (injunctive norm) and the perception of what others are doing (descriptive norm). The personal agency consists of two constructs: perceived control and self-efficacy. Perceived control is determined by the perception of the degree to which various environmental factors may facilitate (or prevent) carrying out the behaviour. Self-efficacy is the perceived confidence in the personal ability to perform the behaviour.

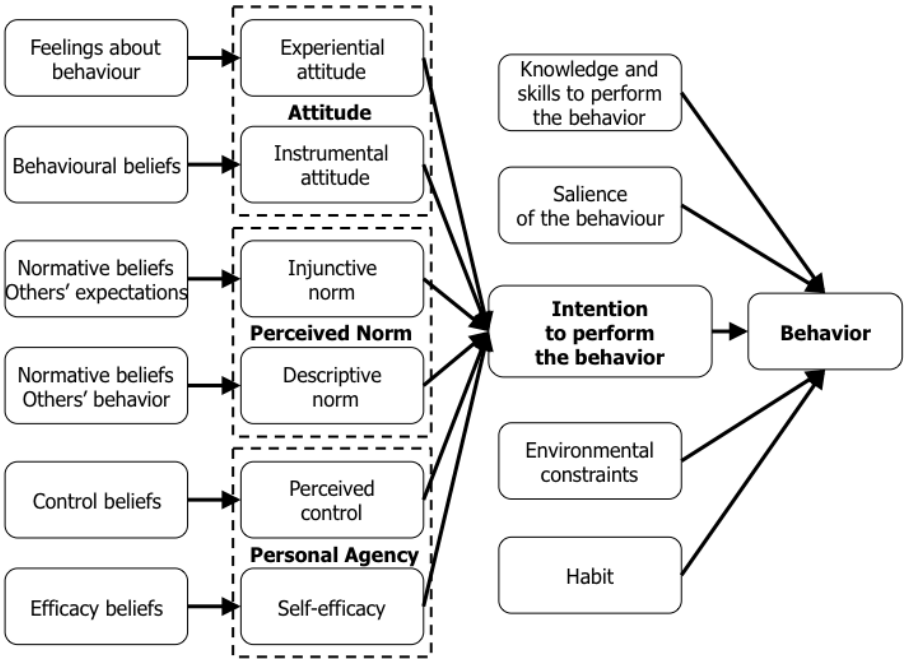

Figure 2. The Integrated Behavioural Model [45].

According to the IBM, the intervention starts from an interview aimed at identifying the factors facilitating or hampering behavioural intention. The results of these interviews can be used to structure the intervention and prepare standardised questionnaires to evaluate impact. The IBM has been successfully used in health care to promote HIV prevention [33], to facilitate physical activity among children [9], as well as to investigate behavioural predictors of college women in following training recommendations [52]. However, to the best of our knowledge, it has not been used in the context of collecting and analysing user requirements.

The paper presents the application of the IBM in a design project as a framework to identify the activities preferred by older adults and the factors that influenced their intention to engage with those activities. Finally, we collapsed the findings from our study into a model describing user requirements activities as desires.

Study on Activities of Older Adults

To inform the design of the ACANTO recommender system, the IBM was applied to shape a model of the activities older people enjoy to engage in. The three constructs of the IBM – attitudes, perceived norms, and personal agency – were employed to structure an interview

study to identify the activities that older adults liked to engage in, and unveil the factors which affected their preferences.

Participants

A total of 18 people participated in the study. Ten of them were interviewed in Trento, Italy (6 females, 4 males; mean age 75, range 65-102) and 8 in Newcastle, UK (4 females, 4 males; mean age 70, range 60-87). Trento is a medium-sized city (117,000 inhabitants approximately) in the North of Italy with a high quality of life. The mean age in the city is approximately 44 years, with 22% of the population over 65 years old [66]. The ageing index (the number of people aged 65 and over per 100 youths under age 15) is approximately 157% [66]. Newcastle upon Tyne is a large city in the North-East of England with around 290,000 inhabitants who have a mean age of approximately 40 years. As of 2015, around 14% of the population were over 65 years and this is predicted to increase to 44% in 2039 [75]. The ageing index based on 2011 census data is approximately 81% [50]. Participants were recruited through older adults associations in Italy and from the NorthEast Age Database in the UK. The Italian sample was evenly distributed among people who lived in the city and people who lived in the countryside. The British sample contained only people who lived in the city.

Interview script

The script was designed according to the IBM factors and pilot tested with 3 participants (2 Italians and 1 British). Transcripts were produced and analysed in a meeting with 8 social-science researchers. This process contributed to the refinement of the questions and the definition of the initial coding scheme. In addition, the first three interviews with the Italian participants were conducted by two female researchers in tandem. They later discussed and analysed the process leading to further improvement in the procedure. One of them individually completed the remaining Italian interviews. A male researcher ran all the interviews in the UK. The final script is reported in the Appendix.

The interview started with a few exploratory questions related to the participant personal circumstances. These questions were used in order to gain a rich understanding of the person and facilitate trust between the researcher and the participant. Then, a generative question was asked to stimulate narratives about daily activities the participants liked to engage in, emphasising both actual and desired behaviour. We did not directly mention physical exercise, but we enquired in general about activities the interviewees liked to do. This decision was justified by related work suggesting that a direct reference to physical exercising may have a negative connotation for some older adults [22]. As a matter of fact, an emphasis on physical exercise – an activity culturally associated with being young and healthy – would have risked priming a negative and stigmatized identity (not young anymore) and a prevention-focussed attitude (no losses). In addition, the choice matched the idea of active ageing as a holistic process, beyond the functional emphasis on physical activity.

Selected activities were probed further using the IBM categories as lines of inquiry. These questions elicited experiential and instrumental attitudes, injunctive and descriptive normative influences, perceived control and self-efficacy. At the end of the interview, a few questions directly enquired about motivators of and barriers to the activities. We probed on

current preferences, inviting participants to elaborate on the activities they declared to enjoy the most at present. In addition, we probed on past preferences, inviting participants to elaborate on activities they liked in the past, but did not do at present.

Procedure

The interviews lasted approximately one hour and were conducted in the native language of the participants and the interviewer. They were carried out at the participant's home or at the offices of the associations involved in the project, according to the participant preferences. The aim of the project was described at the beginning of each interview as a study on preferred activities with no direct reference to ageing and invited to sign a consent form.

Analysis

The interviews were audio recorded and transcribed applying specific criteria to identify linguistic, paralinguistic and extralinguistic aspects. To protect anonymity, each participant was identified by a string of letters (initials and nationality) and numbers (age). The transcripts were analysed with Atlas.ti using deductive thematic analysis [11] and extrapolating all the statements relevant to the IBM constructs. Two researchers worked independently on the Italian sample and double coding was conducted for 20% of data (inter-rater reliability 80%). Disagreements were discussed and resolved to establish a common scheme, which was applied in the UK. Codes were constructed according to the IBM and gathered into 4 code-families: one was associated with activities, the others were labelled as the original categories of the IBM (Attitude, Perceived Norm, and Personal Agency). Each code family was further enriched with specific codes as reported in Table 1. Emotional valency (+/-) was coded for each quote.

As the aim of this study was to develop a model of older user preferred activities, all the interviews were analysed together. Differences between the Italian and the UK sample are noted when relevant but treated as examples of contextual variations in the IBM model. No inferences on cultural differences are proposed in this paper due to inappropriate sampling size and procedure.

Table 1. Results from study on activities of older adults.

Code Family	Codes	Occurrences			
		IT	UK	Total	
				+	-
Activity	1. Activity s/he wishes s/he could do 2. General activities s/he does	136	90	**226**	
				192	**34**
Attitude	1. Experiential attitude 2. Instrumental attitude	37	49	**86**	
				74	**12**
Perceived Norm	1. Injunctive norm 2. Descriptive norm	47	44	**91**	
				88	**3**
Personal Agency	1. Perceived control 2. Self-efficacy	110	70	**180**	
				171	**9**

Results

We collected rich narratives about 55 activities participants enjoyed taking part in. As can be seen from Table 1, their emotional valence was positive most likely because it described things people like to do. These narratives included 47 activities older people currently

engaged in, and 8 activities they liked in the past but were not part of their life anymore. The storytelling about past activities was often nostalgic and tended to account for the majority of the negative emotions accounted in the narratives. It has to be noted that often, the *barriers* precluding participants from performing these activities were only marginally related to physical ageing but involved a complex array of social and economic changes in lifestyle (e.g., need to take care of relatives, economical cost, social isolation).

Activities were clustered around two main categories: *hedonic* and *altruistic*. Hedonic activities aimed to satisfy personal needs leading to self-gratification and pleasure. Some of these activities were *physical* in nature (e.g., walking, going to the gym, dancing, gardening, or yoga); others were *intellectual* (e.g., reading, playing instruments or games). Altruistic activities aimed to satisfy communal needs for both the family and the wider society. In return, these activities produced a feeling of self-worth and respect.

Altruistic activities encompassed taking care of younger or older relatives, as well as volunteering in the form of civic engagement and political commitment. Participants spoke about participation in organising cultural events (e.g., trips, social events, and courses for the University of the Third Age), charity work (e.g., distribution of food, search of accommodation for migrants), and community services (e.g. taking care of community property). In the UK sample, civic engagement was associated with a religious dimension and included activity organised by Parish churches. In the Italian sample a gender effect was noted: only women elaborated on altruistic activity devoted to volunteering. Figure 3 illustrates the occurence as 47 hedonic (physical and intellectual) and altruistic (civic and political) activities, as elaborated by the participants of the two samples. We note a preference for intellectual activities in the UK as compared to Italy.

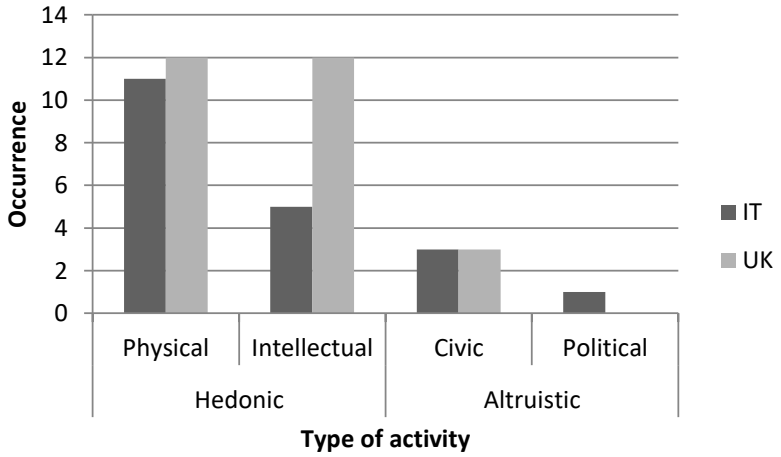

Figure 3. Frequency of activity types in the Italian and UK samples.

Altruistic activities were a minority. Yet, during the interviews, participants often referred to the important contribution they were still making to their family (children, grandchildren or other relatives) and reported on productive activities they continued to after retirement, often with no economic gain. Men, in particular, reported a strong commitment to their past job. It was described as a duty, but they proudly continued to do it whenever possible. Women attributed less importance to their work life, which they mainly referred to as a way to justify their current activities. For example, one woman referred to her professional managerial work as what legitimized her to cover a leading role in a charity. Storytelling

about these activities was fragmented so that we could not apply the IBM to interpret them consistently.

There were some differences in activities reported between the UK and the Italian data stressing the importance of environmental constraint and habits on intention. For example, two UK participants mentioned attending football matches – something likely due to the presence of a large football club in Newcastle upon Tyne. Attendance at large sporting events was never mentioned by Italian participants, who rather elaborated on country site activities, something which can be attributed to their geographical location. UK participants also mentioned a number of predominantly English activities such as croquet and cricket.

Personal Agency

Most of the quotes clustered around the construct of agency which reflected a clear awareness of ageing. Participants described ageing as the natural process that people undergo throughout their lifetime. Self-efficacy was high in the sense that the participants were determined and felt able to keep doing their preferred activities while being aware of either existing or expected physical or cognitive decline (84 occurrences). They had realistic views of their abilities, yet they remained resilient and persistent. Overall, they described ageing as an active and fulfilled period of life that keeps them busy with different activities.

> *"I like everything [laughs] I like many things. I like to photograph, I like to read, but now when I have a computer I read less and less [laughs]. I like to chat, socialize, a lot, and then regarding motoric level I adore swimming and I like going to the mountains."* [FB65FIT]

Five persons elaborated on specific physical constraints (i.e. pain or chronic diseases) but they did not considered them as barriers to continue being active. For example, when asked about walking a participant commented:

> *"Yea [I feel able to keep doing that], as far as I'm physically able. I've got a mildly dodgy knee at the moment but it's not stopping it as I said I walked into town today so it's fine."* [PM63MUK]

The major factor influencing perceived control was accessibility (56) mainly referred to as the physical distance to travel in order to do the activity. For example, a participant elaborated on transport as a main issue that would eventually make it difficult to go to church:

> *"It's easy at the moment because I can just get in the car and go. That's the only problem I'll have eventually, when I don't drive any longer. I mean, I feel there has to be point when you shouldn't be driving any longer. And sometimes I think my husband thinks I may have already reached that point but you know, I don't know. […] Well, I'm thinking in my head, 80* [years of life]." [JM68FUK]

As evident in this quote, participants frequently reported a high internal locus of control that helped them to face the difficulties related to physical ageing (31). Resilience was the

main quality emerging from the narratives, as participants found creative solutions to new and evolving needs. For example, overcoming pain when walking in the woods:

> *"I had ache in my back and I stopped […] I took my umbrella and was not raining, I used the umbrella as a walking stick and it gave me a long walk. My colleague meets me and says: "But look it is not raining my friend, what are you doing with the umbrella?" "Oh if I tell you […] I have pain in my back, I need a support" I said […] With sticks everyone understand you have pain."* [MG69FIT]

Caring duties were mentioned as barriers to engagement in other activities (9 comments). Two participants reported having previously engaged in caregiving while one was currently caring for his wife. Another talked about caring for a friend and how his death affected the structure of her life opening opportunities for new activities. However, caring was not only considered as a burden but as an important and (often) fulfilling aspect of life. Indeed, most of the participants proudly elaborated on their role as a support of the extended family, which often included grand-children. An illustrative example is reported below.

> *"I like to see them [children] I just like to know that they're doing well, and try to help them if I can, in different ways. Maybe financially or other ways, you know […] There was a time when I couldn't have done it because I didn't have the money, but the love was there and that, that can't be bought with money."* [TY80MUK]

Regarding the activities participants had favoured in the past, but could not perform anymore (12 comments), they elaborated on physical barriers (e.g., low vision for embroidery), costs (e.g., photography), and safety concerns (e.g., fear of falling). Their narratives expressed a feeling of nostalgia but no sign of character weakness.

Perceived Norms

Perceived norms regard the amount by which social pressure influence the decision to take part in an activity. Injunctive norms were more heavily dictated by family members, including spouses, children and relatives (26), but also by friends (15). The participants felt a sense of obligation with respect to these networks. To a lesser extent, they could also be influenced by professionals, such as doctors (5), caregivers (1) and trainers (1). A participant appreciated the encouragement received from family in charity food preparation:

> *"My husband has been always giving me a hand, he was also available for me […] My sons and husband get angry sometimes because I tell them that I get tired too much […] but all decisions we make, we make together."* [RV71FIT]

In contrast, friends dictated the descriptive norms. They represented the in-group to which people compared themselves [65]. This group was composed by people of similar interests and it often included both older and younger people (15). In other cases it included people with similar age and life experiences (11). For example, when asked about other people playing croquet a participant noted:

> *"Yea it's a whole mix really […] there was a young girl turned up yesterday which was lovely. In the last club the ethos was oh people can't join if they're young which isn't*

true […] I think it's a shame that it's sometimes sort of put across as an old people's sport you know whereas it's nice if you do get a mix of people who play." [JM62FUK]

In general, participants' decisions were autonomous but only in a very few cases (3), social norms were considered as irrelevant. In these cases, the decision to engage, or not to engage in an activity was considered as completely personal depending on the benefits people gained from it. In all the other cases, descriptive norms were perceived positively. The engagement of friends (11) in favoured activities was considered as more important to define the descriptive norms than the engagement of family members (3).

Attitudes

Reported attitudes were positive and centred on the experience of performing the activity. They can be summarised as mental satisfaction and physical pleasure. *Mental satisfaction* (23) was described as a range of intellectual feelings gained from the fulfilment of different kinds of desires or needs. *Physical pleasure* (18) was described as pleasant physical feelings connected with body movements.

"I would say it [swimming] gives me more on the inside level that is physical, I feel very relaxed for my age […] However, what motivates me is not the physical but how I feel after […] a level of serenity and pleasure, all these things here […] Listen, let me tell you, feel like almost inside the placenta [laughs]." [FB65FIT]

As it clearly emerges in the words of the above participant, physical and mental satisfaction were often entangled and related to both senses and abilities. For instance, physical activities, such as walking or hiking, were described as a way to stay fit and healthy (physical well-being) and as a source of serenity (mental well-being). Mentions of rich sensory experiences frequently emerged in the narratives; such as references to vision while describing animals or plants; hearing regarding natural sounds; touch while talking about the interaction with other people or things; smell and taste when talking about plants or cooking. Furthermore, participants elaborated on cognitive abilities such as attention and concentration (while describing a route, or the ability to recognise a plant), as well as social experiences (walking with friends, acquaintances or other people). A participant elaborated on the multi-sensorial benefits of walking in group:

"Again there's a social contact. The likes are certainly getting out in the fresh air, getting some exercise and also them, you get the opportunity to see things. Bits of wildlife, you know. Even if it's just some snails in the grass you know, there are things out there to see that's them, you maybe don't see in the town." [PM63MUK]

Instrumental attitudes referred to taking part in activities because of the benefits received from participation. The most common benefits were connectedness with important others or meeting new people (15), and maintaining physical health and well-being (14), followed by learning and accomplishment (4). When asked about the gains of taking part in church activities, a participant said:

"Well, just being involved I think, with other people. The spin-off to the church thing is that last year and this year they asked me, would I go round the local businesses in

the area asking for anything towards our autumn fair. Well, last year it was the summer fair but they didn't have one this summer so it's autumn. And I quite enjoy doing that." [CL70FUK]

A model of desires

This study allowed gathering a rich understanding of the lived experiences of healthy older people, their wishes and desires, alongside difficulties and barriers. Participants lived experiences were deeply heterogeneous [71] and strongly influenced by contextual dependences. This heterogeneity reflected the "wicked" nature [59] of the concept of ageing, a social phenomenon that is difficult to manage through traditional processes [40, 55]. The interviews suggested that ageing escapes definite formulation as a unique and stable condition but it needs to be articulated reflecting a variety of personal matters of concerns. Looking at active ageing through the lens of wicked problems and diversity [42] allows a distinct vision of the complexity of the design space. It makes us consider how the same object can have different meanings according to variable perspectives. As an example, consider the use of home sensors, which can increase confidence and privacy concerns at the same time. Wicked problems do not have just one solution but allow for a multiplicity of possible interventions.

Despite this complex heterogeneity, it is possible to identify in the data some shared themes and regularities which can be used to understand what makes activities attractive to older adults. In this analysis, we use the IBM as a descriptive model that provides a person-centric structure to organise user requirements. The model is illustrated in Figure 4 and discussed following the relative importance that the three themes – personal agency, attitudes, and norms – had on the behaviour.

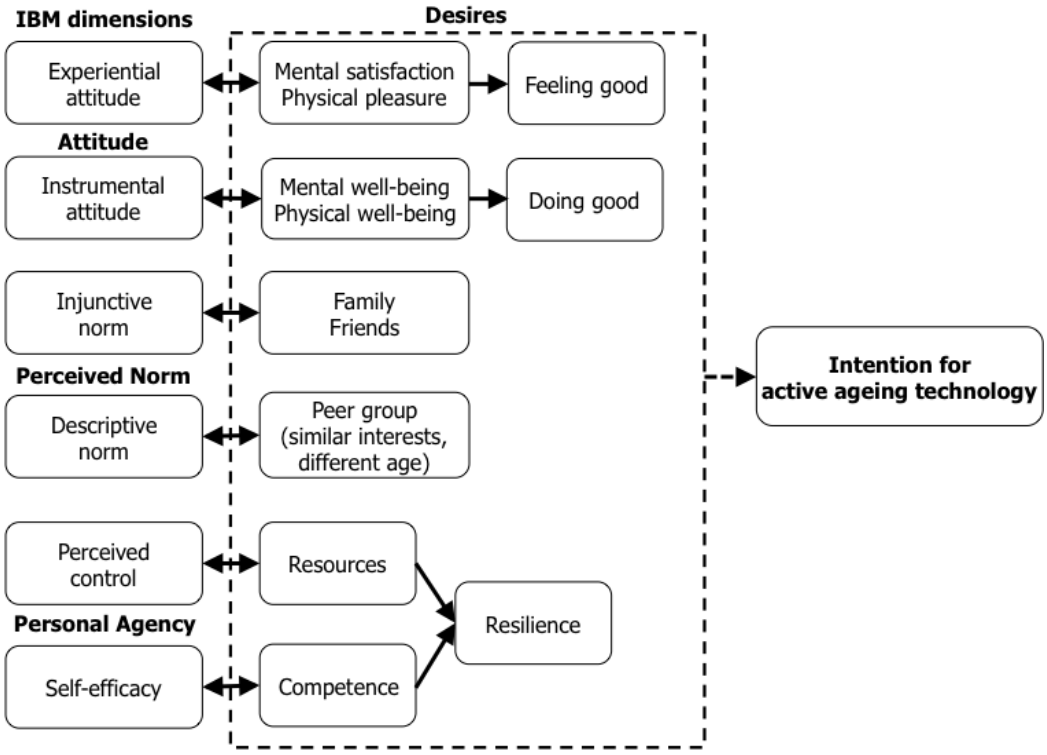

Figure 4. The IBM model of older people desires.

Personal Agency

The construct of personal agency was salient in the interviews, and an acute awareness of ageing permeated its description. This narrative could be partially attributed to a framing effect of the study, but it confirms previous results showing the relevance of age as a main discriminant in social categorisation processes [65]. However, older adults' narratives sharply contrasted with the stereotype of frail and passive creatures [4]. On the contrary, they suggested a profile of active and resilient people with a high internal locus of control and strong self-efficacy. Participants demonstrated *competence*, *resources* and *resilience* to enjoy their preferred activities of everyday life.

Self-efficacy was articulated mainly as competence. This association reflected the positive side of the age stereotype describing older people as wiser than younger [8]. Narratives about ageing were prevalent when participants reflected on their sense of competence. On the one hand, they believed that their competence derived from ageing and were willing to share it. On the other hand, they were aware that ageing implied changes in life but they reported having the know-how to deal with it. The narratives were realistic and positive, suggesting an overall sense of empowerment and ability. These people were in control of their lives and capable to articulate their "want", not only to confirm their "need" [23]. They were creative in elaborating strategies and objects to deal with the variety of challenges encountered through the process of ageing. To maintain control on the environment, older people employed objects as *resources* [30], adapting them and reinventing their functionality to suit new and evolving needs [36]. Several examples of such resourcefulness were evident in the interview, such as the woman who reported preferring an umbrella to a walking stick. The two objects can functionally perform the same task but the umbrella avoids stigmatization as it can be transformed into a fashion accessory. Yet, the umbrella opens serious hazards, as it was not designed to bear weight.

In the model of desires, the concept of resources does not only indicate objects and tools. It also emphasises the role of older people as resources. While supporting their family or volunteering, older people were not only resourceful for themselves but for the society. The combination of competence + resources (self-efficacy + control) gave rise to resilience. Participants' storytelling demonstrated their ability to recover quickly from difficulties as the most distinctive characteristic of later life for healthy adults. Issues of accessibility were however identified as major barriers to resources availability, specifically concerning mobility [43].

Attitudes

Attitudes, in the IBM framework, include both an experiential and an instrumental dimension. Contrary to the bulk of computer science research which focused on satisfying instrumental needs, our data suggest that experiential attitudes were major behavioural drivers. Most of the preferred activities were hedonic in nature and aimed to provide *physical pleasure* and *mental satisfaction*. Physical and mental experiences were entangled across different activities and driven by the need of "feeling good". This may be a trivial result on a psychological perspective, but it is an important disruption to mainstream narratives on technology for active ageing which with a few exceptions [36, 16, 71] has emphasised on functionality and usability while disregarding pleasure and aesthetics [35].

Older users described their preferred activity as sensual and embodied opening new important directions for design.

Instrumental attitudes were characterised by the same entanglement of *mental* and *physical well-being*. However, if the experiential attitude emphasised the importance of personal pleasure, instrumental attitudes emphasised social well-being. “Doing good” was the main driver of instrumental attitudes in this resourceful sample.

Norms

Participants in general demonstrated a high degree of decisional autonomy. They defined social norms around groups that included both friends and family. These social groups exerted different influence over participants. While family and friends had ultimate normative influence, the peer group had significant descriptive influence. This group included also people with similar interests and different ages.

Discussion

Appropriate input from older adults before stepping into the design process is crucial to avoid sociocultural biases and ensure the correct interpretation of their needs [57]. Our study focused on lifestyle (represented as preferred activities) of older people. The IBM model served as a person-oriented requirements tool which transformed needs into desires. In this section we firstly elaborate on the limitations of the study and then compare and contrast the IBM model of desires with related work. Finally, we provide some methodological and practical reflections on the IBM application in design practice.

Methodological considerations

A main limitation of the study reported in this paper is the sample size. The empirical findings are extracted from a small sample that included two different cohorts of older users concerning language, culture and habits. We did not examine how demographic variables (e.g., education or socioeconomic status) or personality traits may have influenced the framework, rather we searched for similarities and patterns as design trajectories. According to the IBM framework [45], this knowledge can now ground future research which is important for the design of active-ageing technology. The IBM model of desires can be refined and validated to provide operational models which can drive more inclusive research. The initial results presented in this paper set the stage for further empirical inquiry, such as for example the design and validation of questionnaires to study the relative importance of personal agency, attitudes and social norms as drivers of different behavioural intention in a larger sample.

While encouraging further empirical research, we compare and contrast current results with studies of older user acceptance of technology to assess the model validity. Overall the IBM model of desires share a number of similarities with related work. The emphasis on personal agency resonates with several studies on technology acceptance and adoption from different epistemological traditions. Two components of the UTAUT relate to the personal agency – performance expectancy and facilitating conditions [70]. Performance expectancy is the perception of how technology can help users in what they want to achieve by using it. Facilitating conditions determine whether it is possible to achieve the behaviour and correspond to the factor “environmental constraints” in the IBM model. The salient barriers

identified in this study also reflected previous work. The most important obstacles were related to health problems [74], inconvenience caused by cost and accessibility [35, 44]. Further similarities can be found with the holistic model proposed by Lee and Coughlin [35]. According to them, older adults are more likely to use technology that gives them competence and helps them remain independent. Such technology should give them control over its affordances and become a resource which they can fit to existing and evolving needs. In addition, technology should not expose signs of frailty or inability thus facilitating resilience.

The IBM model of desires declines personal agency from a person-centric perspective as resources and competence which together give life to resilience, an essential component of active ageing. The knowledge of the type of activities older people like to do and the eventual support they may need can inform the design of technology which promotes competence as a key characteristics of ageing. The behavioural barriers identified in the study correspond to the reasons for non-participation highlighted by previous studies. They mainly address health problems [74], activity cost and accessibility (which in this sample of healthy users is mainly identified as the distance to reach activities) confirming findings from the quantitative [35] and qualitative research [44].

With a few exceptions, the importance of the attitudinal dimension has been disregarded in current research on older user. As a notable exception, Lee and Coughlin [35] list emotion as a factor describing benefits of technology use. Our findings show that the participants had high expectations regarding mental and physical well-being from doing their activities (Figure 3). Older people can see different kinds of values in technology [71]. The attitudes reflect personal values they would expect to fulfil from technology supporting their activities. These values are defined as “feeling good” (experiential theme) and “doing good” (instrumental theme). In addition, according to the work of Mitzner et al. [44] a positive attitude towards technologies assumes support for doing activities.

Social factors influencing technology use are reported from different studies. Waycott et al. [74] describe barriers as family circumstances (e.g., caregiving and opinion of family members) and established social norms (e.g., attitudes of grandchildren). Lee and Coughlin [35] aggregated previous research and defined social influence as the support from family, age peers and community members. The UTAUT [70] defines social influences as the perception of the user about what significant others would think if they started to use the system. Our results define the social influence in a more structured way. Social norms are described for specific categories or groups of people and the type of influence they exert over older adults (family and friends vs peer group). We define peers as not only other older adults as previous research mainly does, but we include those with shared interests regardless of age. This finding suggests new trajectories in technology design to facilitate intergenerational encounters [47].

The emphasis on the person differentiates the IBM from traditional IS models describing user acceptance in terms of system features [19]. In this regard, the IBM has the advantage of bringing the user to the forefront of system analysis and design. As compared to other psychological models [1, 2], the distinctive feature of the IBM is that it specifies attitudes, norms, and agency at a finer-level of details. This granular treatment of behavioural

intention brings forward three main advantages. The first benefit is compositionality as the IBM's fine-grained structure helps to deal with the complexity of the factors that influence user intention. However, this advantage does not come to the detriment of the model simplicity. In fact, for the IBM, the only necessary and sufficient condition is the intention, the rest of the variables are only indirectly related to the behaviour. Attitudes, social norms, and personal agency, each can contribute to foster or inhibit intention (suggesting thus an additive/subtractive relation). The weight of each of these constructs depends on the type of behaviour and person under scrutiny. Future research following a quantitative paradigm is necessary to inform the weighting and distribute researches in design projects.

The second advantage of the IBM relates to a more encompassing view of user behaviour. In contrast to the TRA and TPB, the IBM suggests that other factors, in addition to intention, influence the likelihood of engaging in a behaviour. These factors are knowledge of the behaviour, environmental constraints, behaviour salience and habits (Figure 2). A focus on these external factors is fundamental in the context of requirements elicitation for technology design. The third benefit of the IBM relates to its applied nature, specifically in the field of health study. In this requirements elicitation study, the different constructs have been operationalized by standard questions that are easily adaptable to different case studies and can be used as guide for collecting data in different interventions (Appendix). As a design team familiar with different requirement elicitations techniques we were surprised by the effectiveness of the procedure which allowed to gather a solid understanding of older people desires rather than their needs in a short time [20].

Design consideration

Based on the IBM model of desires, we articulate design implications focussing on aesthetic and resources. Over a decade ago, Newell [49] predicted that the demographic and social changes shaping contemporary ageing were likely to produce the need for incorporating aesthetic design within accessibility products. His reasoning stressed the difference between "want" and "need". The things we "want" usually are beautiful – in the eyes of the beholder at least. The products somebody else decided we "need" may not satisfy the requirement of being beautiful, as functionality was considered to be of utmost importance. The results of the study reported in this paper provides strong evidence to this line of reasoning. There is no reason why assistive devices should be ugly or, at worst, stigmatising. These devices do not motivate users to adopt them and, rather than helping, may hamper them, facilitating for example social isolation instead of networking [39].

Our study confirmed that pleasure and enjoyment play a crucial role in motivating older people. Concepts such as aesthetics, sensuality and feelings define future spaces for active ageing technology. We need to think about new objects which can help users to realize their desires, while expressing their creativity [15]. By elaborating on this trajectory, we can go beyond the medical model that expects older people to be monitored, helped and assisted. Games represent a promising direction for the target sample, as they can engage the whole body in pleasurable experiences. Moreover, we believe that the sense of accomplishment and perceived self-efficacy derived by mastering a game can provide a significant boost to self-esteem. There are varied directions currently explored: they include cognitive and physical training, relaxation, entertainment and socialisation [25, 29, 32, 47, 69].

Building on a hedonic perspective and the work by [27] we articulate a design framework for resourceful ageing on three main guidelines. The first guideline emphasises the role of older people as resources for society, pushing designers to reflect on how this role can be embedded and made visible in the tools they design. The second guideline regards objects and tools as resources, which can flexibly be adapted to changing environments according to the user's desires [24]. The third guideline emphasizes agency and power; it encourages a life-course perspective and challenges the tendency to look at issues for older people in isolation from the rest of society. This assumption represents the core of inclusive design [76].

By grounding design on resourceful ageing, the focus shifts from the creation of tools in support of older people, to the construction of devices that improve self-efficacy. On the one hand, it is of interest for designers to investigate possibilities for exposing the positive image of older people as active and resilient, making visible their skills, knowledge and abilities while respecting their desires [54]. On the other hand, designers have the opportunity to work on the creation of a sustainable ecosystem of human and material resources, while amplifying their social value with technological tools. Such an ecosystem can be self-sustainable, because it encourages older people to become agents for problem-solving and problem-framing associated with ageing [40]. The framework of resourceful ageing suggests interesting design trajectories related to volunteering and family caregiving. There is substantial evidence that volunteers reported higher levels of well-being and life satisfaction compared to non-volunteers [3, 34, 68].

In an eight-year-long study of over than 1,200 adults above the age of 65, Musick and colleagues [48] documented that volunteers have a lower risk of dying than non-volunteers, even after controlling the effects of physical health, socioeconomic status, and social connectedness. Moen et al. [46] studied a sample of 300 women over a 30-year period and found that earlier volunteering was related to functional ability at a later stage of life. The willingness to volunteer demonstrates that older people are not only resourceful for themselves (meaning that they struggle to make up with existing objects for their weaker physical and cognitive abilities), but that they are resourceful for society. Older people are more likely to have the time, the skills and the drive to benefit others.

This consideration pushes designers to reflect on how this resilient agency can be embedded in the tools they create. Fighting ageism is a promising venture for critical design interventions aimed to challenge the status quo and subvert narratives [5, 42]. Technologies for active ageing should not expose the limitations of later life [72] but rather celebrate older people as active and resilient, making visible their skills, knowledge and abilities. By grounding design on resourceful ageing, the focus shifts from the creation of tools in support of older people, to the construction of devices which improve personal agency.

Conclusion

This paper provides the IBM model of user desires for active ageing technology. It is a descriptive model of user requirements framed as desires for doing preferred activities. The model was based on an interview study with older users. We start from the premise that active-ageing technology design should facilitate activities of older adults. A model of desires is defined in terms of the psychological theory of human behaviour that describes

the intention to engage in the behaviour as a function of attitudes, social norms and personal agency. Our results show that the personal agency is the most influential factors on the behavioural decision, followed by perceived norms and attitudes, respectively. The model defines user requirements as desires to engage with activities as follows: *"feeling good"* and *"doing good"* (attitudes); *family*, *friends* and *peer group* characterised by common interests and mixed age (perceived norms); and *resources*, *competence* and *resilience* (personal agency). Based on our findings, we propose the design implications as design for pleasure and design for resourceful ageing. The next step of this research is to use the model of user desires (Figure 4) to inform the design of the ACANTO recommendation engine.

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Appendix

Category	Question (with probes)
Activity	Can you tell me about your everyday life ? a. Who do you live with ? b. What is your normal mode of transport ? c. Do you live in a rural area ? Urban area ? d. What sort of groups do you belong to/attend (e.g. church, bowling club, walking group) ? e. What activities do you like to take part in? How frequently do you do each one ? f. Who do you do these activities with ? g. How do the seasons affect your activities (i.e. summer and winter) ? h. Are there any activities you would like to be able to do but don't currently ?
Experiential attitude	What do you like about the activity ? What do you dislike about the activity ?
Instrumental attitude	What do you expect to gain from taking part in this activity ?
Injunctive norm	How important is it what other people think ? Whose opinion matters most ? What do significant others (e.g friends, family, doctor) think about you doing this activity ?
Descriptive norm	What sort of other people take part in this activity ?
Perceived control	How much control do you have about taking part in this activity ? What sort of things or people make it easy for you to take part in this activity when you want to ? What sort of things or people prevent you doing this activity when you want to ?
Self-efficacy	Do you feel able to keep doing this activity ? How well can you perform this activity ?